

PSYCHE.

THE RELATION OF SEX TO HELIOTROPISM IN THE BROWN-TAIL MOTH.¹

BY WILLIAM REIFF, HARVARD UNIVERSITY.

FOR the purpose of obtaining statistical data concerning the attractive power of electric light for the various orders of insects, during the spring of 1909 we had built upon the grounds of the Bussey Institution a light trap of large dimensions. A more detailed description of this trap will be given later after I have been able to gather together for publication the data concerning the various material collected, but for the present it will suffice to state that the source of light was an arc light consuming a current of seven and a half amperes. The light was burned regularly each evening from sunset until two hours before sunrise.

In connection with the amount of brown-tail moth material obtained it should be mentioned that all nests in the neighborhood of the Institution had been carefully removed during the spring so that the moths could not be present in abundance. The daily weather conditions were noted shortly after sunset. The results are indicated in the table on p. 116.

We can see from the table that during the first twelve days, only a single female flew to the light. During this time we had either moonlight nights, or when it was cloudy, an abnormally low temperature for this time of the year; then as the moonlight decreased and the temperature rose, a few females were attracted. The unusually warm 13th of June brought large numbers of both sexes on a night of feeble moonlight. While males of the brown-tail moth had appeared more or less regularly on all other days during the flying time, no females came when the temperature sank below 19° C. The proportionate numbers of the two sexes on the same days were extremely variable. An unusually warm night undoubtedly has the greatest influence in attracting both sexes to the electric light, but if there should be at the same time a very noticeable moonlight the number of females will remain far below that of

¹ Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 10.

Date	Temperature (centigrade)	Barometer	Weather Conditions	Number of moths flying to light.				Totals.
				♂	♀	ab. puncti- gera Teich.		
						♂	♀	
1909 6/29	21°	29.84	Bright moonlight, occa- sional light clouds, damp air.	1				1
6/30	23°	29.74	Very bright moonlight, clear.					
7/1	23°	29.52	Very bright moonlight, clear.	4				4
7/2	21°	29.58	Cloudy sky.	4				4
7/3	19.5°	29.42	Very bright moonlight, clear, windy.	1				1
7/4	19°	29.61	Very bright moonlight, occasional light clouds.	4				4
7/5	19°	29.82	Bright moonlight, clear.	26	1			27
7/6	15°	29.86	Bright moonlight, occa- sional light clouds.	20				20
7/7	11°	29.78	Cloudy sky.	12				12
7/8	16°	29.64	Light clouds.	20				20
7/9	19°	29.88	Weak moonlight, clear.	10				10
7/10	19°	30.01	" " "	14				14
7/11	20°	29.94	" " "	15	2	1		18
7/12	23°	29.69	Cloudy sky.	11	2	1		14
7/13	26°	29.56	Very weak moonlight, clear.	117	100	11		228
7/14	25°	29.81	Cloudy sky.	22	12			34
7/15	24°	29.93	" "	18	1			19
7/16	22°	29.68	Light clouds.	24	4			28
7/17	22.5°	29.76	New moon, clear.	30	15			45
7/18	22°	29.64	Rain till ten, then clear.	21				21
7/19	18.5°	29.74	New moon, clear.	12				12
7/20	19°	30.02	" " "	4				4
7/21	18°	30.03	" " "	3				3
7/22	19°	29.92	Light clouds.	3	1			4
7/23	17°	29.66	Cloudy, rainy.	2				2
7/24	21°	29.71	Slight moonlight, clear.					
7/25	21°	29.84	" " "	1				1
7/26	24°	29.95	" " "					
7/27	25°	29.92	" " "					
7/28	27°	29.99	Bright moonlight, clear.					
7/29	26°	29.84	Very bright moonlight, occasional light clouds.					
7/30	26°	29.63	Very bright moonlight occasional light clouds.	2				2
			Total	401	138	13		
			Grand Total					552

males. Besides, the normal flying time of the males (June 29–July 30) is shown by the table to be nearly twice as long as that of the females (July 5–July 22). On this account the males have much more frequent opportunities to fly to light, aside from the fact that the males are produced in greater quantity than the females.— Only thirteen male specimens of the aberration *punctigera* Teich flew to the light.

It has often been said that the females of the brown-tail moth are attracted to electric lights in only very small numbers. The statistics obtained this year which I have given, show, however, that the attraction of females is dependent in great measure upon the weather conditions which prevail during the flying time, so that it may be different in successive years, and a proportion applicable to all years cannot be given. The foregoing table shows that the proportion of males to females for the flying period of 1909 is about 4:1, but the proportion of males and females on single days is extremely variable. Thus while the unpleasant 18th of July shows the greatest preponderance of males over females (21:0), the pleasant night of July 13th attracted the sexes in the ratio of 1.2:1. The 14th and 17th of July were also favorable for the flying of females and although the combined number of both sexes attracted on these nights was not much above the average, the ratio of males to females was 1.8:1 and 2:1 respectively.

I had the opportunity of observing a similarly favorable proportion of the two sexes about electric lights at Raymond, N. H., on the 17th of July, in a locality which had been badly damaged by the brown-tail moth. Although I do not know exactly what the temperature and pressure were at Raymond on the night of the 17th, the thermometer probably registered about 22°–23° C. and the barometer in the neighborhood of about 29.70. In addition the moon was new and the air still and dry. Immediately after dark both males and females came flying to the electric light in enormous numbers. The flight of each individual lasted for hardly a minute, for they almost immediately searched for a resting place close to the light, either on the light pole or the wires leading to the light. Here the most noticeable feature was the abundance of pairs in copulation; hardly had a female settled when she would be surrounded by numerous males seeking to unite with her. The female very quickly made her selection and remained with her mate during the whole night in the bright light. Even on the following morning, numerous pairs could be observed in the same places. As nearly as I could make out, every female which came to the light paired with a male, at least not one single female was observed which was not in copulation. The moths stopped coming to the light at about eleven o'clock. An exact count of the specimens could not be undertaken on account of the great abundance of the species, and also because many specimens on trees surrounding the

light escaped observation. The ratio of the sexes can therefore be given only in a general way from the notes which I made concerning three arc lights.

On lamp No. 1	were found about	530	♂♂	and	350	♀♀
“ “ “ 2	“ “ “	310	♂♂	“	220	♀♀
“ “ “ 3	“ “ “	390	♂♂	“	240	♀♀
		1230 ♂♂		“	810 ♀♀	

The ratio of males to females was therefore in this case 1.5 : 1. Strange to say, the aberration *punctigera* Teich was entirely absent among the large number of specimens. These observations at Raymond give further evidence for the statement that females of the brown-tail moth are attracted to electric lights almost as strongly as the males, although the flight of the female is particularly affected by the weather conditions which prevail at the time of emergence. That the females at Raymond had just emerged on the 17th of July is shown by the fact that they went into copulation at the light. They must undoubtedly have just emerged, for if the females had left the pupa cases one or more days before, they would have copulated previously, since it is known that members of the Liparidæ and related families copulate during the first twelve hours after emergence. The certainty that females of the brown-tail moth also fly in numbers to electric lights on favorable evenings, has therefore an economic value in the destruction of this species. As the females have naturally not laid eggs before the flight to the lights, the regular destruction each night of the adult females would prevent a possible later egg-laying on the trees in the neighborhood.

I might also mention a simple yet effective method which was utilized this year for the destruction of brown-tail moths in various places in New Hampshire. On still nights, during the flight of the moths they built under the electric arc-lights bonfires, which were well moistened before being lighted. The smoke thus produced did not ascend so far up as the height of the lamp so that the light was not obscured. The brown-tail moths circling about the light soon flew into the clouds of smoke, then falling into the fire to their death. As a result there were windrows of the brown-tail moths 4-5 cm. high about the periphery of the bonfire, and one can judge of the enormous numbers of moths which were killed by this means.